

# Chapter Prerequisite Skills

## PREREQUISITE SKILLS QUIZ

### Review Vocabulary

equation, p. 85  
inequality, p. 138  
least common multiple (LCM), p. 187  
least common denominator (LCD), p. 188

**Preparing for Success** To prepare for success in this chapter, test your knowledge of these concepts and skills. You may want to look at the pages referred to in blue for additional review.

- 1. Vocabulary** Describe how to find the least common denominator of two fractions.

**Solve the equation. Check your solution.** (p. 97)

2.  $4q = 48$       3.  $-9p = 81$       4.  $\frac{n}{4} = 8$       5.  $\frac{m}{-5} = 3$

**Solve the inequality. Graph your solution.** (p. 144)

6.  $3s > -27$       7.  $-7r > 49$       8.  $\frac{x}{-4} \leq -6$       9.  $\frac{y}{3} < -12$

**Use the LCD to determine which fraction is greater.** (p. 187)

10.  $\frac{3}{4}, \frac{7}{9}$       11.  $\frac{2}{7}, \frac{3}{5}$       12.  $\frac{7}{8}, \frac{5}{6}$       13.  $\frac{13}{15}, \frac{11}{18}$

**Simplify.** (p. 194)

14.  $\frac{18x^2}{24x}$       15.  $\frac{16a^3}{22a}$       16.  $\frac{15z^3}{63z}$       17.  $\frac{27m^4}{45m^2}$

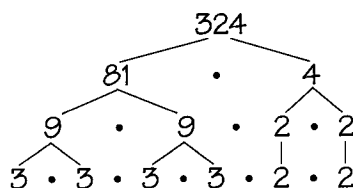
## NOTETAKING STRATEGIES

### Note Worthy

You will find a notetaking strategy at the beginning of each chapter. Look for additional notetaking and study strategies throughout the chapter.

**USING YOUR HOMEWORK** When you are doing your homework and come to an exercise you don't understand, write a question for your teacher. Ask the question the next time you have class.

Write the prime factorization of 324.



Does it matter in what order I write the factors?  
Ask in class tomorrow.

The prime factorization is  $3^4 \cdot 2^2$ .

As you do your homework in Chapter 5, write down questions you have about performing operations on fractions and mixed numbers.

## 5.1

**Vocabulary**

rational number,  
p. 219  
terminating decimal,  
p. 219  
repeating decimal,  
p. 219

**Rational Numbers****BEFORE**

You wrote decimals and fractions.

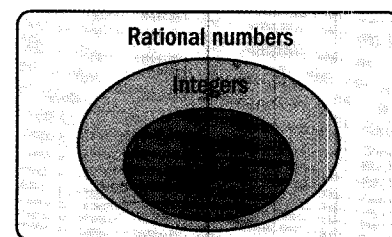
**Now**

You'll write fractions as decimals and vice versa.

**WHY?**

So you can assess a recycling plan, as in Ex. 45.

A **rational number** is a number that can be written as a quotient of two integers. Whole numbers and integers are part of the set of rational numbers, as shown in the Venn diagram.

**Example 1****Identifying Rational Numbers**

Show that the number is rational by writing it as a quotient of two integers.

a. 7

b.  $-10$

c.  $5\frac{3}{4}$

d.  $-3\frac{1}{2}$

**Solution**

a. Write the integer 7 as  $\frac{7}{1}$ .

b. Write the integer  $-10$  as  $\frac{-10}{1}$  or  $\frac{10}{-1}$ . These fractions are equivalent.

c. Write the mixed number  $5\frac{3}{4}$  as the improper fraction  $\frac{23}{4}$ .

d. Think of  $-3\frac{1}{2}$  as the opposite of  $3\frac{1}{2}$ . First write  $3\frac{1}{2}$  as  $\frac{7}{2}$ . Then you can write  $-3\frac{1}{2}$  as  $-\frac{7}{2}$ . To write  $-\frac{7}{2}$  as a quotient of two integers, you can assign the negative sign to either the numerator or the denominator. You can write  $\frac{-7}{2}$  or  $\frac{7}{-2}$ .

**Review Help**

For help with writing mixed numbers as improper fractions, see p. 778.

**Terminating and Repeating Decimals** If you take a rational number in the form  $\frac{a}{b}$  and carry out the division of  $a$  by  $b$ , the quotient will be either a *terminating decimal* or a *repeating decimal*. In a **terminating decimal**, the division ends because you obtain a final remainder of zero. In a **repeating decimal**, a digit or block of digits in the quotient repeats without end. Example 2 on page 220 shows how to write both a terminating decimal and a repeating decimal.

## Reading Algebra

When you use a bar to show which digit or digits repeat in a decimal, be sure to put the bar over only the repeating digits.

For example,

$$0.45555\ldots = 0.4\overline{5}$$

$$3.26767\ldots = 3.2\overline{67}$$

### Example 2

### Writing Fractions as Decimals

a. Write  $\frac{3}{8}$  as a decimal.

$$\begin{array}{r} 0.375 \\ 8 \overline{)3.000} \\ \underline{24} \phantom{00} \\ 60 \phantom{0} \\ \underline{56} \phantom{0} \\ 40 \phantom{0} \\ \underline{40} \\ 0 \end{array}$$

**Answer** The remainder is 0, so the decimal is a terminating decimal:  $\frac{3}{8} = 0.375$ .

b. Write  $\frac{5}{11}$  as a decimal.

$$\begin{array}{r} 0.4545\ldots \\ 11 \overline{)5.0000} \\ \underline{44} \phantom{000} \\ 60 \phantom{00} \\ \underline{55} \phantom{00} \\ 50 \phantom{00} \\ \underline{44} \phantom{00} \\ 60 \phantom{00} \\ \underline{55} \phantom{00} \end{array}$$

**Answer** Use a bar to show the repeating digits in the repeating decimal:  $\frac{5}{11} = 0.\overline{45}$ .

### Checkpoint

Write the fraction or mixed number as a decimal.

1.  $\frac{3}{10}$

2.  $-\frac{2}{3}$

3.  $1\frac{9}{20}$

4.  $\frac{29}{80}$



### In the Real World

**Biology** The yellow-bellied marmot belongs to the order Rodentia. Yellow-bellied marmots typically live at elevations from 6500 feet to 13,500 feet. Find the difference of these two elevations.

### Example 3

### Using Decimals to Compare Fractions

**Biology** Of the 50 mammal species found in Canyonlands National Park, 20 species belong to the order Rodentia. Of the 54 mammal species found in Badlands National Park, 24 belong to Rodentia. In which park is the fraction of mammal species belonging to Rodentia greater?

#### Solution

- 1) Write a fraction for each park. Then write each fraction as a decimal by dividing the numerator by the denominator.

$$\begin{array}{l} \text{Canyonlands} \\ \text{National Park} \end{array} \quad \frac{\text{Rodentia species}}{\text{Mammal species}} = \frac{20}{50}$$

$$= 0.4$$

**Write fraction.**

**Divide.**

$$\begin{array}{l} \text{Badlands} \\ \text{National Park} \end{array} \quad \frac{\text{Rodentia species}}{\text{Mammal species}} = \frac{24}{54}$$

$$= 0.444\ldots$$

$$= 0.\overline{4}$$

**Write fraction.**

**Divide.**

**Repeating digit**

- 2) Compare the decimals. By writing 0.4 as 0.400, you can see that 0.444... is greater than 0.400. So  $0.\overline{4} > 0.4$ , and  $\frac{24}{54} > \frac{20}{50}$ .

**Answer** The fraction in Badlands National Park is greater.

## Note Worthy

In your notebook, you may want to include a list of common fraction-decimal equivalents. You can refer to the list when solving problems, or you may want to memorize the list. Here are some examples you might include:

$$\frac{1}{2} = 0.5, \frac{1}{3} = 0.\overline{3},$$

$$\frac{1}{4} = 0.25, \frac{1}{8} = 0.125$$

**Writing Decimals as Fractions** To write a terminating decimal as a fraction or a mixed number, use the place of the last digit to determine the denominator of the fraction, as shown in Example 4. Example 5 shows a method for writing a repeating decimal as a fraction.

### Example 4

#### Writing Terminating Decimals as Fractions

a.  $0.7 = \frac{7}{10}$

7 is in tenths' place, so denominator is 10.

b.  $-3.05 = -3\frac{5}{100}$

5 is in hundredths' place, so denominator is 100.

$$= -3\frac{1}{20}$$

Simplify fraction.

### Example 5

#### Writing a Repeating Decimal as a Fraction

To write  $0.\overline{93}$  as a fraction, let  $x = 0.\overline{93}$ .

- 1) Because  $0.\overline{93}$  has 2 repeating digits, multiply each side of  $x = 0.\overline{93}$  by  $10^2$ , or 100. Then  $100x = 93.\overline{93}$ .

2) Subtract  $x$  from  $100x$ .

$$\begin{array}{r} 100x = 93.\overline{93} \\ - (x = 0.\overline{93}) \\ \hline 99x = 93 \end{array}$$

3) Solve for  $x$  and simplify.

$$\frac{99x}{99} = \frac{93}{99}$$

$$x = \frac{31}{33}$$

**Answer** The decimal  $0.\overline{93}$  is equivalent to the fraction  $\frac{31}{33}$ .

### ✓ Checkpoint

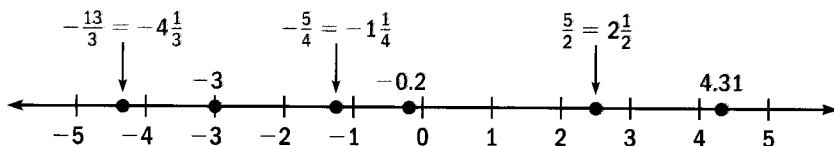
5. **Critical Thinking** Compare writing 0.3 as a fraction with writing  $0.\overline{3}$  as a fraction.

### Example 6

#### Ordering Rational Numbers

Order the numbers  $-\frac{5}{4}$ ,  $-0.2$ ,  $4.31$ ,  $-3$ ,  $\frac{5}{2}$ ,  $-\frac{13}{3}$  from least to greatest.

Graph the numbers on a number line. You may want to write improper fractions as mixed numbers.



Read the numbers from left to right:  $-\frac{13}{3}$ ,  $-3$ ,  $-\frac{5}{4}$ ,  $-0.2$ ,  $\frac{5}{2}$ ,  $4.31$ .

## Study Strategy

**Another Way** To order the numbers in Example 6, you can instead write the fractions as decimals. Then order the decimals.

# 5.1 Exercises

More Practice, p. 807



## Guided Practice

**Vocabulary Check** Tell whether the number is a *terminating decimal* or a *repeating decimal*.

1. 0.667      2. 0.4747...      3. 35.35      4.  $2.\overline{43}$   
5. How can you tell whether a number is a rational number?

**Skill Check** Show that the number is rational by writing it as a quotient of two integers.

6. 15      7. -2      8.  $5\frac{4}{7}$       9.  $-1\frac{1}{3}$

Write the fraction or mixed number as a decimal.

10.  $\frac{2}{9}$       11.  $1\frac{4}{5}$       12.  $-\frac{13}{15}$       13.  $-9\frac{5}{8}$

Write the decimal as a fraction or mixed number.

14. 0.4      15. 0.324      16.  $0.\overline{78}$       17.  $2.\overline{6}$

18. **Swim Teams** Of the 20 students on the girls' swim team, 9 are seniors. Of the 24 students on the boys' swim team, 10 are seniors. On which team is the fraction of students who are seniors greater?

19. **Error Analysis** Describe and correct the error in writing the repeating decimal  $5.07878...$  using a bar.

**X**  $5.07878... = 5.\overline{078}$

## Practice and Problem Solving

### Homework Help

#### Example Exercises

- 1 20-27  
2 28-35  
3 44-45  
4 36-43  
5 49-56  
6 45, 57-60



- More Examples
- eTutorial Plus

Show that the number is rational by writing it as a quotient of two integers.

20. 24      21. -29      22.  $5\frac{7}{18}$       23.  $-\frac{1}{8}$   
24. 1      25.  $-2\frac{3}{7}$       26. 0.3      27. 0.87

Write the fraction or mixed number as a decimal.

28.  $\frac{1}{5}$       29.  $-\frac{7}{8}$       30.  $-\frac{5}{3}$       31.  $\frac{19}{6}$   
32.  $3\frac{4}{25}$       33.  $-\frac{13}{11}$       34.  $8\frac{5}{44}$       35.  $-13\frac{7}{10}$


Write the decimal as a fraction or mixed number.

36. 0.54      37. 0.63      38. 7.6      39. 2.093  
40. -0.85      41. 0.019      42. -5.895      43. -1.102

- 44. Leaves** You and a friend are collecting leaves. In your collection of 45 leaves, 4 are oak leaves. In your friend's collection of 36 leaves, 3 are oak leaves. Whose collection has a greater fraction of oak leaves?

- 45. Recycling** The table shows monthly amounts of trash and recycled trash at a school.

Month	Total trash (lb)	Recycled trash (lb)
Nov.	350	112
Dec.	315	119
Jan.	270	189
Feb.	330	234
Mar.	300	214

- a. For each month, find the fraction of trash that was recycled.
- b.  **Compare** Use a calculator to write the fractions in part (a) as decimals. Order the decimals from least to greatest. In which month was the fraction of trash that was recycled the greatest?
- c. *Writing* As of January 1, a new recycling plan was introduced at the school. What effect do you think the plan had on recycling efforts in January and the months that followed? Explain.

**Copy and complete the statement using *always*, *sometimes*, or *never*.**

46. An integer is ? a rational number.
47. A fraction can ? be written as a terminating decimal.
48. A repeating decimal is ? a rational number.

**Write the decimal as a fraction or mixed number.**

49.  $0.\overline{8}$       50.  $0.\overline{7}$       51.  $-0.\overline{4}$       52.  $-9.\overline{6}$
53.  $0.\overline{12}$       54.  $-1.\overline{36}$       55.  $0.\overline{897}$       56.  $2.\overline{707}$

**Order the numbers from least to greatest.**

57.  $-2, \frac{7}{8}, 0.8, 2.1, 1\frac{1}{3}$       58.  $0.7, -1, -\frac{5}{4}, \frac{4}{3}, -2.3, -\frac{9}{2}$
59.  $0.21, 2.3, \frac{8}{3}, -0.1, -\frac{1}{5}, 0.\overline{2}$       60.  $0.3, 0.\overline{3}, 0.\overline{30}, -0.3, -0.\overline{3}$

- 61. Extended Problem Solving** The table shows the number of at bats and hits that players on a softball team had in three games.

Player	Game 1		Game 2		Game 3	
Maria	4 at bats	2 hits	5 at bats	2 hits	4 at bats	1 hit
Laura	4 at bats	1 hit	5 at bats	1 hit	4 at bats	1 hit
Jenny	4 at bats	3 hits	4 at bats	2 hits	4 at bats	1 hit

- a. Find the total number of at bats and the total number of hits for each player for the three games.
- b. **Analyze** A player's batting average is the total number of hits divided by the total number of at bats. The batting average is usually expressed as a decimal rounded to the nearest thousandth. Find each player's batting average for the three games.
- c. **Apply** Rank the players based on batting averages. Explain.



- 62. Measurement** You have a rope that is  $4\frac{1}{3}$  feet long. Your friend has a rope that is  $1\frac{1}{2}$  yards long. Who has the longer rope?
- 63. Critical Thinking** Try using a calculator to find a decimal value for  $\frac{1}{17}$ . What do you notice? Then use long division to write  $\frac{1}{17}$  as a terminating or repeating decimal. Explain the calculator result you obtained.
- 64. Critical Thinking** Let  $a$  and  $b$  represent nonzero integers. Find a rational number in the form  $\frac{a}{b}$  so that  $-1.7 < \frac{a}{b}$  and  $\frac{a}{b} < -\frac{5}{3}$ . Explain how you found the number.
- 65. Challenge** Write the decimal  $0.\overline{321}$  as a fraction.

### Mixed Review Simplify the expression. (Lesson 2.3)

**66.**  $k - 9 - (2 + k)$

**67.**  $m + 5 - 2(m + 7)$

### Find the least common multiple of the numbers. (Lesson 4.4)

**68.** 240, 340

**69.** 18, 60

**70.** 55, 77

**71.** 27, 189

- 72. Chemistry** A common number used for calculations in chemistry is Avogadro's number, which is approximately equal to  $6.02 \times 10^{23}$ . Write this number in standard form. (Lesson 4.7)

### Standardized Test Practice

- 73. Multiple Choice** Which number is *not* equivalent to  $\frac{40}{66}$ ?

**A.**  $\frac{20}{33}$

**B.**  $\frac{60}{99}$

**C.**  $0.\overline{6}$

**D.**  $0.\overline{60}$

- 74. Multiple Choice** Which number is greater than  $-1.5$ ?

**F.**  $-1.\overline{5}$

**G.**  $-\frac{3}{2}$

**H.**  $-1.\overline{45}$

**I.**  $-\frac{7}{2}$

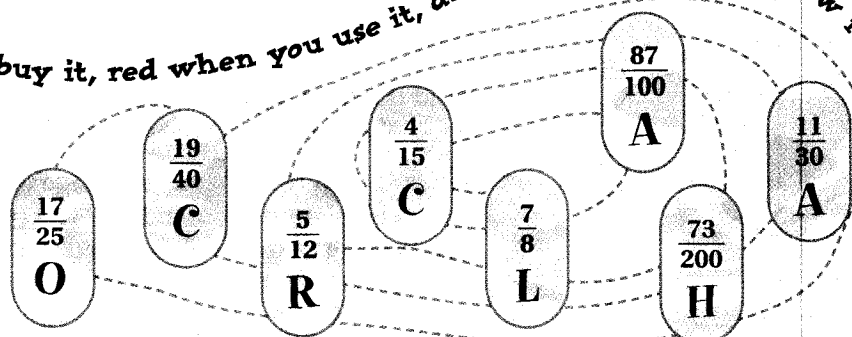
- 75. Short Response** Write  $0.\overline{475}$  as a fraction. Describe the steps you take to write the fraction.

## Brain GAME

What is black when you buy it, red when you use it, and gray when you throw it away?

Order the fractions from least to greatest. The corresponding letters spell out the answer to the riddle.

### Rational Number Riddle



# Adding *and* Subtracting Like Fractions

## Review Vocabulary

variable expression,  
p. 5

### BEFORE

You added and subtracted decimals.

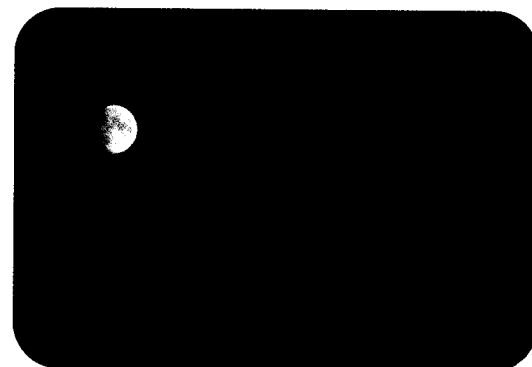
### Now

You'll add and subtract like fractions.

### WHY?

So you can analyze a lobster's growth, as in Ex. 52.

**Astronomy** One night,  $\frac{77}{100}$  of the moon's visible surface is illuminated. The next night, an additional  $\frac{9}{100}$  is illuminated. What fraction of the moon's visible surface is illuminated on the second night?



## Adding and Subtracting Like Fractions

**Words** To add or subtract fractions with the same denominator, write the sum or difference of the numerators over the denominator.

**Numbers**  $\frac{4}{9} + \frac{1}{9} = \frac{5}{9}$

$$\frac{9}{11} - \frac{2}{11} = \frac{7}{11}$$

**Algebra**  $\frac{a}{c} + \frac{b}{c} = \frac{a+b}{c}, c \neq 0$

$$\frac{a}{c} - \frac{b}{c} = \frac{a-b}{c}, c \neq 0$$

## Review Help

For help with adding and subtracting fractions, see p. 779.

### Example 1

### Adding Like Fractions

To find the fraction of the moon's visible surface that is illuminated on the second night, as described above, find the sum of  $\frac{77}{100}$  and  $\frac{9}{100}$ .

$$\frac{77}{100} + \frac{9}{100} = \frac{77+9}{100}$$

Write sum of numerators over denominator.

$$= \frac{86}{100} = \frac{43}{50}$$

Add. Then simplify.

**Answer** On the second night,  $\frac{43}{50}$  of the visible surface is illuminated.

## Study Strategy

When you perform operations with negative fractions, be sure to assign a negative sign in front of a fraction to the numerator of the fraction. For instance, in part (a) of

Example 2,  $-\frac{4}{7}$  is written as  $\frac{-4}{7}$ .

### Example 2

### Subtracting Like Fractions

$$\begin{aligned}\text{a. } -\frac{4}{7} - \frac{2}{7} &= \frac{-4-2}{7} \\ &= \frac{-6}{7} = -\frac{6}{7}\end{aligned}$$

Write difference of numerators over denominator.

Subtract.

$$\begin{aligned}\text{b. } \frac{1}{10} - \left(-\frac{3}{10}\right) &= \frac{1}{10} + \frac{3}{10} \\ &= \frac{1+3}{10} \\ &= \frac{4}{10} = \frac{2}{5}\end{aligned}$$

To subtract  $-\frac{3}{10}$ , add  $\frac{3}{10}$ .

Write sum of numerators over denominator.

Add. Then simplify.

### ✓ Checkpoint

Find the sum or difference.

1.  $\frac{3}{8} + \frac{2}{8}$

2.  $-\frac{1}{6} + \frac{5}{6}$

3.  $\frac{2}{15} - \frac{7}{15}$

4.  $\frac{1}{12} - \left(-\frac{7}{12}\right)$

**Mixed Numbers** To add or subtract mixed numbers, you can first write the mixed numbers as improper fractions.

### Example 3

### Adding and Subtracting Mixed Numbers

$$\begin{aligned}\text{a. } 5\frac{5}{9} + 2\frac{7}{9} &= \frac{50}{9} + \frac{25}{9} \\ &= \frac{50+25}{9} \\ &= \frac{75}{9} \\ &= \frac{25}{3} = 8\frac{1}{3}\end{aligned}$$

Write mixed numbers as improper fractions.

Write sum of numerators over denominator.

Add.

Simplify. Then write fraction as a mixed number.

$$\begin{aligned}\text{b. } -10\frac{6}{13} - 6\frac{8}{13} &= \frac{-136}{13} - \frac{86}{13} \\ &= \frac{-136-86}{13} \\ &= \frac{-222}{13} = -17\frac{1}{13}\end{aligned}$$

Write mixed numbers as improper fractions.

Write difference of numerators over denominator.

Subtract. Then write fraction as a mixed number.

### ✓ Checkpoint

Find the sum or difference.

5.  $2\frac{3}{4} + 1\frac{3}{4}$

6.  $-6\frac{2}{3} + 3\frac{1}{3}$

7.  $4\frac{1}{5} - 2\frac{3}{5}$

8.  $-3\frac{2}{7} - 6\frac{3}{7}$

## Review Help

For help with simplifying fractions that include variables, see p. 184.

### Example 4

### Simplifying Variable Expressions

a.  $\frac{3a}{20} + \frac{5a}{20} = \frac{3a + 5a}{20}$  Write sum of numerators over denominator.

$$= \frac{8a}{20}$$

Add. Divide out common factor.

$$= \frac{2a}{5}$$

Simplify.

b.  $-\frac{8}{3b} - \left(-\frac{2}{3b}\right) = -\frac{8}{3b} + \frac{2}{3b}$  To subtract  $-\frac{2}{3b}$ , add  $\frac{2}{3b}$ .

$$= \frac{-8 + 2}{3b}$$

Write sum of numerators over denominator.

$$= \frac{-6}{3b}$$

Add. Divide out common factor.

$$= \frac{-2}{b} = -\frac{2}{b}$$

Simplify.

## 5.2 Exercises

More Practice, p. 807



### Guided Practice

#### Vocabulary Check

- Copy and complete: To find the sum of two fractions with the same denominator, write the sum of the ? over the denominator.
- Explain how to simplify the expression  $\frac{5m}{3} + \left(-\frac{2m}{3}\right)$ .

#### Skill Check Find the sum or difference.

3.  $\frac{7}{9} + \frac{1}{9}$

4.  $-\frac{2}{7} + \frac{5}{7}$

5.  $\frac{3}{8} - \frac{5}{8}$

6.  $5\frac{9}{13} + 9\frac{8}{13}$

7.  $-3\frac{7}{16} - 8\frac{11}{16}$

8.  $1\frac{3}{14} - 10\frac{5}{14}$

#### Guided Problem Solving

9. **Crafts** You have  $5\frac{1}{4}$  feet of ribbon. You want to cut one piece that is  $3\frac{3}{4}$  feet long and one that is  $1\frac{3}{4}$  feet long. Do you have enough ribbon?
- Write  $3\frac{3}{4}$  and  $1\frac{3}{4}$  as improper fractions.
  - Find the sum of the improper fractions.
  - Compare the sum in Step 2 with  $5\frac{1}{4}$  to determine whether you have enough ribbon.

# Practice and Problem Solving

## Homework Help

Example	Exercises
1	10-17, 27
2	10-17
3	18-25, 28, 37, 44
4	29-36



- More Examples
- eTutorial Plus

Find the sum or difference.

10.  $\frac{3}{5} + \frac{4}{5}$

11.  $\frac{12}{19} + \frac{8}{19}$

12.  $-\frac{17}{27} - \frac{13}{27}$

13.  $\frac{3}{7} - \left(-\frac{6}{7}\right)$

14.  $\frac{13}{15} + \left(-\frac{8}{15}\right)$

15.  $-\frac{21}{26} + \frac{15}{26}$

16.  $\frac{9}{22} - \frac{19}{22}$

17.  $-\frac{6}{17} - \frac{12}{17}$

18.  $4\frac{1}{4} - 5\frac{3}{4}$

19.  $3\frac{4}{5} + \left(-8\frac{4}{5}\right)$

20.  $6\frac{3}{10} + 7\frac{9}{10}$

21.  $\frac{1}{3} - \left(-2\frac{2}{3}\right)$

22.  $8\frac{9}{11} - 3\frac{6}{11}$

23.  $-5\frac{5}{18} - \frac{17}{18}$

24.  $3\frac{7}{16} - 8\frac{11}{16}$

25.  $2\frac{1}{14} - 11\frac{3}{14}$

26. **Error Analysis** Describe and correct the error in adding  $-\frac{3}{7}$  and  $\frac{2}{7}$ .

$$\begin{array}{rcl} -\frac{3}{7} + \frac{2}{7} & = & \frac{-3+2}{7+7} \\ & & = -\frac{1}{14} \end{array}$$

X

27. **Homework** One day, you studied math for  $\frac{3}{4}$  hour and English for  $\frac{3}{4}$  hour. What was the total time that you studied both subjects?

28. **Baking** A blueberry muffin recipe calls for  $1\frac{2}{3}$  cups of flour. A banana muffin recipe calls for  $2\frac{2}{3}$  cups of flour. How much flour do you need to make both recipes?

Simplify the expression.

29.  $\frac{5x}{8} + \frac{x}{8}$

30.  $\frac{t}{13} + \frac{12t}{13}$

31.  $-\frac{11}{6p} + \frac{17}{6p}$

32.  $\frac{29}{12s} + \frac{19}{12s}$

33.  $\frac{2n}{15} - \frac{7n}{15}$

34.  $\frac{m}{21} - \frac{5m}{21}$

35.  $-\frac{5}{18a} - \frac{23}{18a}$

36.  $-\frac{15}{4d} - \frac{21}{4d}$

37. **Carpentry** You are making a shelf from a board that is  $12\frac{3}{4}$  inches long. You want to cut the board so that it is  $10\frac{1}{4}$  inches long. What length should you cut from the board?

Evaluate the expression.

38.  $\frac{3}{9} + \frac{7}{9} + \frac{4}{9}$

39.  $\frac{3}{10} + \frac{5}{10} + \left(-\frac{7}{10}\right)$

40.  $-\frac{7}{9} + \frac{2}{9} + \left(-\frac{4}{9}\right)$

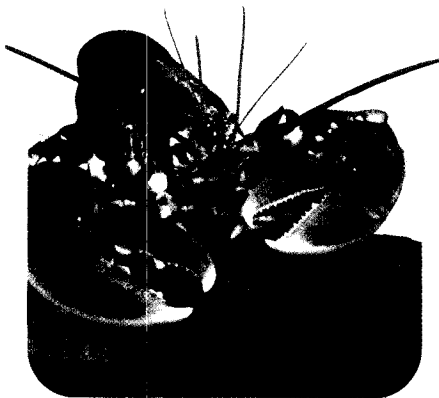
41.  $\frac{1}{5} - \left(-\frac{3}{5}\right) + \frac{2}{5}$

42.  $-\frac{17}{31} - \frac{21}{31} - \frac{27}{31}$

43.  $-\frac{13}{14} - \frac{11}{14} - \frac{9}{14}$

44. **Shot Put** The school record for the shot put is 45 feet,  $3\frac{3}{8}$  inches. Your personal record is 42 feet,  $6\frac{7}{8}$  inches. How much farther must you throw the shot put to match the school record?





### In the Real World

**Lobsters** Suppose a lobster molts 25 times during the first 7 years of its life. After that, it molts once per year. After 12 years, how many times will it have molted?

- 45. Critical Thinking** Find two fractions, one positive and one negative, having the same denominator and a sum of  $\frac{1}{2}$ .

**Solve the equation. Check your solution.**

**46.**  $x + \frac{3}{7} = \frac{5}{7}$

**47.**  $y + \frac{8}{11} = \frac{2}{11}$

**48.**  $-\frac{7}{12} + z = -\frac{5}{12}$

**49.**  $m + 2\frac{4}{9} = 5\frac{2}{9}$

**50.**  $7\frac{3}{8} = n + 6\frac{5}{8}$

**51.**  $-1\frac{5}{13} + t = 4\frac{10}{13}$

- 52. Lobsters** A lobster periodically sheds its shell and grows a new shell. During this process, which is called molting, the weight of the lobster increases, as shown in the table.

Lobster Weights (lb)	
Before molting	$1\frac{1}{4}$
After 1 molting	$1\frac{3}{4}$
After 2 moltings	$2\frac{2}{4}$
After 3 moltings	$3\frac{3}{4}$
After 4 moltings	$5\frac{1}{4}$

- How many pounds did the lobster gain after each molting?
- How many pounds in all did the lobster gain after four moltings?
- Suppose the lobster gains  $2\frac{1}{4}$  pounds after molting one more time. How much does it weigh then?

- 53. Challenge** Solve the equation  $\frac{5}{8} + \frac{7x}{3} = \frac{8x}{3}$ . Explain how you found the solution.

### Mixed Review

- 54. Watch** You buy a watch and a battery for \$57.99. The battery costs \$2.99. Write and solve an equation to find the cost of the watch. (Lesson 2.5)

**Write the fraction in simplest form.** (Lesson 4.3)

**55.**  $\frac{15s^3}{5s^2}$

**56.**  $\frac{120t^2}{140t^5}$

**57.**  $\frac{65m^4}{80m^2}$

**58.**  $\frac{54a^5}{78a^2}$

**Find the least common multiple of the monomials.** (Lesson 4.4)

**59.**  $18m, 3mn$

**60.**  $5t, 20s^2t$

**61.**  $12a^3b, 6a$

**62.**  $9vw, 36v^2w^2$

### Standardized Test Practice

- 63. Multiple Choice** Find the difference  $\frac{13}{16} - \left(-\frac{7}{16}\right)$ .

**A.**  $-1\frac{1}{4}$

**B.**  $-\frac{3}{8}$

**C.**  $\frac{3}{8}$

**D.**  $1\frac{1}{4}$

- 64. Multiple Choice** Simplify the expression  $\frac{16}{3y} - \frac{28}{3y}$ .

**F.**  $-\frac{12}{3y}$

**G.**  $-\frac{4}{y}$

**H.** 0

**I.**  $\frac{44}{3y}$

- 65. Short Response** A rectangular picture frame is made of wooden strips that are  $\frac{3}{4}$  inch wide. The outside edge of the frame is  $8\frac{1}{4}$  inches long and  $6\frac{3}{4}$  inches wide. Can a rectangular picture that is 7 inches long and  $5\frac{1}{2}$  inches wide fit inside the frame? Explain your answer.

## 5.3 Combining Fractions with Different Denominators

### Goal

Use area models to add and subtract fractions with different denominators.

### Materials

- paper
- colored pencils

### Investigate

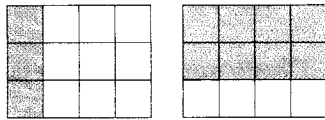
Use area models to add and subtract fractions.

To model finding the sum  $\frac{1}{4} + \frac{2}{3}$ , follow the steps below.

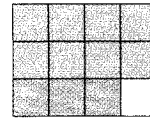
- 1** Draw area models for  $\frac{1}{4}$  and  $\frac{2}{3}$ , as shown.



- 2** Redraw the models so they have the same number of equal parts.



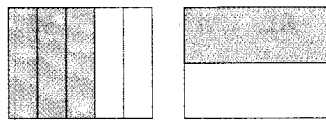
- 3** Combine the shaded parts to find the sum.



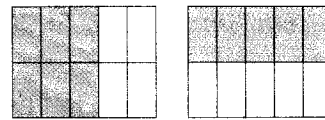
$$\frac{1}{4} + \frac{2}{3} = \frac{11}{12}$$

To model finding the difference  $\frac{3}{5} - \frac{1}{2}$ , follow the steps below.

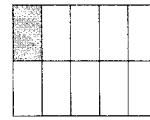
- 1** Draw area models for  $\frac{3}{5}$  and  $\frac{1}{2}$ , as shown.



- 2** Redraw the models so they have the same number of equal parts.



- 3** Find the difference of the numbers of shaded parts in the two models.



$$\frac{3}{5} - \frac{1}{2} = \frac{1}{10}$$

### Draw Conclusions

Use area models to find the sum or difference.

1.  $\frac{3}{4} + \frac{1}{6}$

2.  $\frac{1}{2} + \frac{2}{7}$

3.  $\frac{2}{3} - \frac{1}{4}$

4.  $\frac{5}{6} - \frac{2}{5}$

5. **Critical Thinking** Show how you can use an area model to find the difference  $2 - \frac{2}{5}$ .

# Adding *and* Subtracting Unlike Fractions

## Review Vocabulary

least common denominator (LCD), p. 188

BEFORE

You worked with like fractions.

Now

You'll add and subtract unlike fractions.

WHY?

So you can find the range of salamander lengths, as in Ex. 34.

**Hiking** You are hiking between two campsites in the Chesapeake and Ohio Canal National Historic Park. The distance between the campsites is  $10\frac{1}{5}$  miles. You have already hiked  $5\frac{3}{4}$  miles. How many more miles do you have to hike? Example 3 answers this question by finding the difference of two mixed numbers.



To add or subtract fractions with different denominators, begin by using the LCD of the fractions to write equivalent fractions that have the same denominator.

## Review Help

For help with finding the least common denominator (LCD) of two or more fractions, see p. 188.

### Example 1

### Adding and Subtracting Fractions

$$\text{a. } \frac{5}{12} + \frac{1}{3} = \frac{5}{12} + \frac{4}{12}$$

Write  $\frac{1}{3}$  using LCD.

$$= \frac{5+4}{12}$$

Write sum of numerators over denominator.

$$= \frac{9}{12}$$

Add.

$$= \frac{3}{4}$$

Simplify.

$$\text{b. } -\frac{5}{6} - \frac{7}{9} = -\frac{15}{18} - \frac{14}{18}$$

Write fractions using LCD.

$$= \frac{-15-14}{18}$$

Write difference of numerators over denominator.

$$= \frac{-29}{18}$$

Subtract.

$$= -1\frac{11}{18}$$

Write fraction as a mixed number.

## Study Strategy

**Reasonableness** You can use estimation to check the reasonableness of an answer. In Example 2, you can estimate the result by adding  $-4\frac{1}{2}$  and  $-2\frac{1}{2}$ . Because the sum,  $-7$ , is close to  $-6\frac{52}{55}$ , the answer is reasonable.

### Example 2

#### Adding Mixed Numbers

$$\begin{aligned} -4\frac{2}{5} + \left(-2\frac{6}{11}\right) &= \frac{-22}{5} + \left(\frac{-28}{11}\right) \\ &= \frac{-242}{55} + \left(\frac{-140}{55}\right) \\ &= \frac{-242 + (-140)}{55} \\ &= \frac{-382}{55} = -6\frac{52}{55} \end{aligned}$$

Write mixed numbers as improper fractions.

Write fractions using LCD.

Write sum of numerators over denominator.

Add. Then write fraction as a mixed number.

### ✓ Checkpoint

Find the sum or difference.

1.  $-\frac{2}{3} + \frac{1}{4}$

2.  $\frac{3}{10} - \frac{4}{5}$

3.  $-\frac{4}{15} - \frac{9}{10}$

4.  $3\frac{5}{9} + 2\frac{1}{6}$

5.  $6\frac{7}{10} + \left(-1\frac{1}{5}\right)$

6.  $-2\frac{1}{3} + 6\frac{3}{5}$

### Example 3

#### Subtracting Mixed Numbers

How many more miles do you need to hike before you reach the next campsite in the Chesapeake and Ohio Canal National Historic Park, as described on page 231?

**Solution**

Your total hiking distance is  $10\frac{1}{5}$  miles. You have already hiked  $5\frac{3}{4}$  miles. To find the remaining distance, subtract.

$$\begin{aligned} 10\frac{1}{5} - 5\frac{3}{4} &= \frac{51}{5} - \frac{23}{4} \\ &= \frac{204}{20} - \frac{115}{20} \\ &= \frac{204 - 115}{20} \\ &= \frac{89}{20} = 4\frac{9}{20} \end{aligned}$$

Write mixed numbers as improper fractions.

Write fractions using LCD.

Write difference of numerators over denominator.

Subtract. Then write fraction as a mixed number.

**Answer** You need to hike  $4\frac{9}{20}$  miles, or about  $4\frac{1}{2}$  miles.

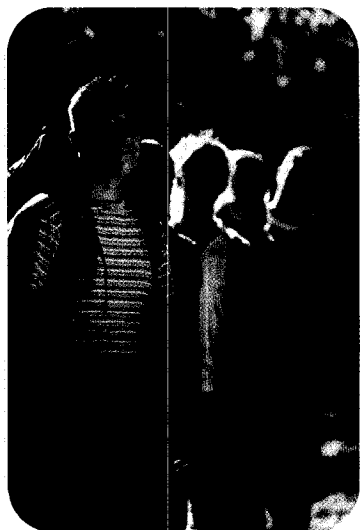
### ✓ Checkpoint

Find the difference.

7.  $5\frac{4}{11} - 2\frac{2}{3}$

8.  $-1\frac{3}{7} - 2\frac{3}{14}$

9.  $4\frac{3}{8} - \left(-1\frac{2}{3}\right)$



**Example 4****Simplifying an Expression**Simplify the expression  $\frac{a}{2} - \frac{a}{6}$ .

$$\frac{a}{2} - \frac{a}{6} = \left( \frac{a}{2} \cdot \frac{3}{3} \right) - \frac{a}{6}$$

Write  $\frac{a}{2}$  using LCD.

$$= \frac{3a}{6} - \frac{a}{6}$$

Multiply.

$$= \frac{3a - a}{6}$$

Write difference of numerators over denominator.

$$= \frac{2a}{6}$$

Subtract.

$$= \frac{\cancel{2}a}{\cancel{6}3}$$

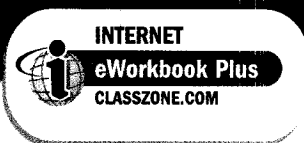
Divide out common factor.

$$= \frac{a}{3}$$

Simplify.

**5.3 Exercises**

More Practice, p. 807

**Guided Practice****Vocabulary Check**

1. What is the LCD of  $\frac{2}{3}$  and  $\frac{1}{2}$ ?
2. Explain how to add two fractions with different denominators.

**Skill Check**

Find the sum or difference.

3.  $-\frac{1}{4} + \frac{1}{8}$

4.  $-\frac{3}{4} - \frac{1}{3}$

5.  $-4\frac{3}{5} + 7\frac{4}{15}$

6.  $2\frac{7}{12} - 9\frac{2}{3}$

Simplify the expression.

7.  $\frac{a}{15} + \frac{a}{6}$

8.  $\frac{b}{8} + \frac{b}{12}$

9.  $\frac{5a}{3} - \frac{a}{6}$

10.  $-\frac{d}{5} - \frac{5d}{6}$

**Guided Problem Solving**

11. **Lumber** Newly cut lumber contains a lot of moisture. Before the wood is used for carpentry or construction, it is usually dried. Suppose a freshly cut board weighs  $10\frac{1}{2}$  pounds. After drying, the board weighs  $4\frac{2}{3}$  pounds. What was the weight of the water that evaporated?
  - 1 Write  $10\frac{1}{2}$  and  $4\frac{2}{3}$  as improper fractions.
  - 2 Rewrite the improper fractions using the LCD of the fractions.
  - 3 Find the difference of the improper fractions from Step 2.

# Practice and Problem Solving

## Homework Help

Example	Exercises
1	12-23
2	24-33, 45-50
3	24-31, 34, 45-50
4	36-43



Online Resources  
CLASSZONE.COM

- More Examples
- eTutorial Plus

Find the sum or difference.

12.  $\frac{1}{12} + \frac{3}{16}$       13.  $\frac{5}{6} + \left(-\frac{2}{3}\right)$       14.  $-\frac{7}{10} + \frac{7}{20}$       15.  $-\frac{1}{9} - \frac{5}{18}$   
 16.  $-\frac{4}{15} - \frac{7}{25}$       17.  $\frac{5}{8} - \frac{11}{14}$       18.  $-\frac{6}{7} + \left(-\frac{16}{21}\right)$       19.  $-\frac{1}{5} - \left(-\frac{2}{11}\right)$

Evaluate the expression when  $m = -\frac{5}{12}$  and  $n = \frac{7}{9}$ .

20.  $m + n$       21.  $m - n$       22.  $n - m$       23.  $-m - n$

Find the sum or difference.

24.  $5\frac{1}{4} + 1\frac{2}{5}$       25.  $-3\frac{3}{4} + 10\frac{7}{8}$       26.  $6\frac{7}{18} - 8\frac{21}{54}$       27.  $2\frac{5}{13} - \left(-1\frac{1}{2}\right)$   
 28.  $-4\frac{7}{10} - 9\frac{7}{15}$       29.  $3\frac{1}{2} - \left(-2\frac{1}{3}\right)$       30.  $-1\frac{5}{12} + 4\frac{5}{14}$       31.  $15\frac{1}{6} - 7\frac{3}{10}$

32. **Snow** On one day it snows  $2\frac{1}{2}$  inches. On the next day it snows  $2\frac{1}{4}$  inches, and on the third day it snows  $4\frac{1}{8}$  inches. What was the total amount of snowfall over the three-day period?
33. **Geometry** The width of a rectangle is  $2\frac{3}{8}$  inches. The rectangle is  $1\frac{3}{4}$  inches longer than it is wide. Find the length of the rectangle and the perimeter of the rectangle.
34. **Salamanders** Texas blind salamanders have been found in lengths varying from  $3\frac{1}{4}$  inches to  $5\frac{3}{8}$  inches. Find the range of these lengths.
35. **Extended Problem Solving** A catalog gives the information below about hats. Head size is the distance around a person's head.

Hat size	Small		Medium		Large		Extra Large	
Head size (in.)	$21\frac{1}{8}$	$21\frac{1}{2}$	$21\frac{7}{8}$	$22\frac{1}{4}$	$22\frac{5}{8}$	23	$23\frac{1}{2}$	$23\frac{7}{8}$

## In the Real World

**Salamanders** The Texas blind salamander inhabits underground streams whose average temperature is about  $21^{\circ}\text{C}$ . Use the formula  $F = 1.8C + 32$ , where  $F$  is the temperature in degrees Fahrenheit, and  $C$  is the temperature in degrees Celsius, to convert the average stream temperature to degrees Fahrenheit.

- a. **Analyze** For each hat size, find the range in head sizes.
- b. **Apply** The catalog says that if your head size is between two hat sizes, you should buy the larger hat size. You are ordering hats for friends whose head sizes (in inches) are  $22\frac{1}{2}$ ,  $21\frac{3}{4}$ ,  $21\frac{5}{8}$ ,  $23\frac{3}{4}$ ,  $22\frac{1}{8}$ , and  $22\frac{3}{8}$ . How many hats of each size should you buy?
- c. **Writing** If you assume that customers always measure head size to the nearest  $\frac{1}{8}$  inch, how would you revise the table to include all possible head sizes between 21 inches and 24 inches?

**Simplify the expression.**

36.  $\frac{d}{6} + \frac{2d}{9}$

37.  $-\frac{y}{5} + \frac{y}{7}$

38.  $\frac{3a}{2} - \frac{a}{6}$

39.  $-\frac{9r}{11} - \frac{r}{8}$

40.  $\frac{4z}{7} - \frac{7z}{4}$

41.  $-\frac{x}{8} + \frac{x}{12}$

42.  $-\frac{5c}{3} - \frac{4c}{15}$

43.  $-\frac{5w}{12} + \frac{7w}{9}$

44. **Horses** Of the three different types of horses on a ranch,  $\frac{1}{4}$  are Arabians,  $\frac{2}{5}$  are Thoroughbreds, and the rest are Morgans. What fraction of the horses are Morgans?

**Evaluate the expression.**

45.  $5\frac{1}{2} + 1\frac{1}{4} + 2\frac{1}{2}$

46.  $-\frac{2}{3} + 1\frac{5}{6} - \frac{3}{4}$

47.  $\frac{3}{4} + \frac{11}{12} - 1\frac{3}{4}$

48.  $1\frac{1}{2} - \frac{3}{8} + 3\frac{4}{5}$

49.  $-\frac{3}{5} - 1\frac{2}{15} - \frac{7}{10}$

50.  $5\frac{13}{64} - \left(-\frac{3}{16}\right) + 1\frac{1}{8}$

51. **Critical Thinking** Can you use 48 as a common denominator when you find the sum of  $\frac{7}{8}$  and  $\frac{5}{12}$ ? Will you get the same answer that you do if you use the least common denominator of the fractions? Compare the steps you would use to find the sum using each common denominator.

52. **Challenge** Find a value of  $x$  so that the sum  $\frac{1}{x} + \frac{3}{2x}$  is equal to 1. Explain how you found your answer.

## Mixed Review

**Find the product.** (p. 780)

53.  $8 \times \frac{3}{4}$

54.  $\frac{5}{8} \times 16$

55.  $\frac{6}{7} \times 21$

56.  $20 \times \frac{3}{5}$

**Find the product or quotient. Write your answer using exponents.**  
(Lesson 4.5)

57.  $b^3 \cdot b^8$

58.  $c^2 \cdot c^5$

59.  $\frac{d^5}{d^7}$

60.  $\frac{3a^6}{a^2}$

61. **Track and Field** The school record for the javelin throw is 186 feet,  $2\frac{1}{4}$  inches. Your personal record for the javelin throw is 172 feet,  $\frac{3}{4}$  inch. Suppose you want to match the school record. By how much do you need to increase the distance you can throw the javelin? (Lesson 5.2)

## Standardized Test Practice

62. **Multiple Choice** Find the sum  $-6\frac{1}{2} + \frac{5}{8}$ .

A.  $-7\frac{1}{16}$

B.  $-7\frac{1}{8}$

C.  $-5\frac{7}{8}$

D.  $-5\frac{7}{16}$

63. **Multiple Choice** Simplify the expression  $\frac{x}{4} - \frac{5x}{6}$ .

F.  $-\frac{4x}{12}$

G.  $-\frac{7x}{12}$

H.  $\frac{4x}{12}$

I.  $\frac{7x}{12}$

### Note Worthy

You should write down any questions you have about performing operations on fractions in your notebook.

# Mid-Chapter Quiz

Write the fraction or mixed number as a decimal.

1.  $\frac{1}{12}$

2.  $-\frac{42}{56}$

3.  $-\frac{7}{4}$

4.  $1\frac{6}{11}$

Write the decimal as a fraction or mixed number.

5. 0.55

6. -4.22

7.  $0.\overline{8}$

8.  $0.\overline{54}$

Find the sum or difference.

9.  $\frac{2}{15} + \frac{7}{15}$

10.  $-\frac{1}{6} + \frac{5}{6}$

11.  $\frac{11}{12} - \frac{7}{12}$

12.  $-\frac{13}{30} + \frac{17}{30}$

13.  $-\frac{1}{4} + \frac{2}{9}$

14.  $\frac{2}{3} - \frac{9}{14}$

15.  $\frac{11}{28} - \frac{25}{42}$

16.  $-\frac{3}{4} + \left(-\frac{17}{25}\right)$

17.  $-4\frac{9}{10} - 2\frac{3}{10}$

18.  $3\frac{1}{4} + 5\frac{3}{4}$

19.  $-1\frac{1}{4} + \frac{11}{18}$

20.  $-10\frac{1}{2} - 14\frac{3}{5}$

Simplify the expression.

21.  $\frac{9d}{12} - \frac{d}{12}$

22.  $\frac{7}{3a} + \frac{5}{3a}$

23.  $-\frac{7c}{9} + \frac{c}{6}$

24.  $\frac{b}{14} - \frac{b}{22}$

25. **Jogging** You are jogging on a trail around a pond. The distance around the pond is  $1\frac{5}{16}$  miles. So far, you have jogged  $\frac{3}{8}$  mile. How much farther do you need to jog before you have gone exactly once around the pond?

## Brain GAME

### Magic Square

Arrange the fractions  $\frac{1}{10}$ ,  $\frac{3}{20}$ ,  $\frac{1}{5}$ ,  $\frac{1}{4}$ ,  $\frac{3}{10}$ ,  $\frac{7}{20}$ ,  $\frac{2}{5}$ , and  $\frac{9}{20}$  in the square so that the sum of the numbers in each row, column, and diagonal is  $\frac{3}{4}$ .

